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A study on sexual dimorphism in fingerprint ridge density among medical students of Nellore south coastal district of Andhra Pradesh

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ABSTRACT

Background: Fingerprints are unique, and each fingerprint of an individual differs from another. Studies were conducted to know how various factors like Race, Sex, and certain disorders influence fingerprint patterns. Similary, the number of ridges present in an area of palms and fingers and their variations were also studied.
Objective: To study the sexual variations in fingerprint ridge density among medical students studying in Narayana Medical college from Andhra Pradesh.
Materials and Methods: Fingerprints of one hundred and twenty medical students (sixty male and sixty female) were analyzed for this study.
Results: The mean ridge density in males is 128.5 (Range 124 -134) for ten digits, and in females, the mean ridge density for ten fingers is 148. 67 and (Range 145 -153). Average ridge density for 0.25sq.cm. in Male:Female is 12.85:14.86.
Conclusion: The females exhibit higher ridge density than males; ridge density of more than 14 ridges of a finger in a 0.25 sq. mm area indicates that the finger likely belongs to a female.

1. Introduction

Human beings are highly developed mammals in the animal kingdom. As each human being differs from another, so do the fingerprints (Quetelets law).[1] No two fingerprints match even in homozygous twins.

Sir William Herschel used fingerprints for the identification of an individual in India in 1858 to prevent impersonation.[2] Sir Francis Galton systematized it to identify criminals, which was officially adopted in England in 1894 and was modified further by Sir Edward Henry 2, hence called the Galton system or Henry-Galton system.

Since then, various studies were conducted on fingerprints. The authors conducted studies on the Inheritance of finger prints[3] and Fingerprint patterns in diseases like Diabetes and Hypertension.[4]

Like similarities, there are many dissimilarities in fingerprints due to racial, familial and sexual differences. Studies were conducted to study sexual dimorphism in fingerprints.[5,6] In Forensic practice, the whole palm or sometimes the whole finger may not be available; in such cases, sex determination may help Investigating officer in solving the case. Given this, studies were done on Sex determination by counting the number of ridges in palm,[7,8] and fingers both in India and abroad.[9]

This inspired us to take up this study on fingerprint ridge density and its sexual dimorphism.

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2. Materials and Methods

The materials used for this were.

1. Inkpad (Black/Blue color)
2. Printed pro forma
3. Consent form
4. A magnifying glass with the light source
5. Graph paper.

Subjects were chosen from medical students studying in Narayana Medical College, Nellore Andhra Pradesh. 120 Medical students (60 girls + 60 boys) participated in the study. The procedure and the purpose of the examination were explained to them, and consent was obtained.

2.1. Collection of the prints

The subjects were asked to wash their hands with soap and water before taking the prints. Inkpad is used for smudging their fingers with ink. Then the smudged fingers were applied carefully in the respective spaces in the pro forma. Only plain prints were obtained. No roll prints were taken.

After taking the Plain fingerprints of all the ten digits of 120 Medical students (60 girls + 60 boys), the total number ridges per 0.25sq.cm from each finger were counted by using a graph paper with a hole made of 0.25 sq. cm. (0.5 X 0.5 cms.) from the prominent central area. The magnifying glass was used while counting to get a better look. The counting was done, and all precautions were taken to avoid Inter and Intraobserver variations.

The results thus obtained were fed into the computer, and the statistical data is analyzed.

2.2. Inclusion and Exclusion Criteria

The students above 18 years of age with all ten fingers and without any finger deformities of hands were included in the study after taking informed consent.

This study has the approval of the institutional ethical committee.

3. Statistical Analysis and Results

The data has been entered into MS-Excel, and statistical analysis has been done using IBM SPSS Version 25.0. For categorical variables, the data values are represented as numbers and percentages., the chi-square test is used to test the association between them. For continuous variables, the data values are shown as mean and standard deviation. The student's t-test is used to test the mean difference between the two groups. All the P-values having less than 0.05 are considered statistically significant. (Tables 1 and 2)

The results indicate the mean ridge density in males is 128.5 (Range 124 -134) for ten digits and for five fingers of left hand is 64.38 (Range 62-67) and that of right hand is 64.11 (Range 62 – 67). The average finger ridge density for each finger is 12.85 ridges / 0.25 sq cms.

In females, the mean ridge density for ten fingers is 148. 67 and (Range 145 -153) for five fingers of left hand is 73.38 (range 71-75) and 75.28 (Range 72-78) for right hand. The ridge density for each finger is 14.86/ 0.25 sq cms.

There is no statistically significant difference in fingerprint ridge density of left and right hands in males, but in females, the ridge density in the right hand is slightly more than the left. (75.28:73.38).

4. Discussion

Many studies were conducted on fingerprint ridge density to determine sexual dimorphism in India as well as abroad.

Sudesh Gungadin[9] conducted a study on 500 subjects (250 male and 250) female in Karnataka. According to this study, the females showed an increased fingerprint ridge density than males. The mean values of females to males were 146 and 128, respectively. Similar results were observed in our study.

In the study conducted in South India involving 100 males and 100 females by Kumar S, Jirli, Prasanna, Honnungar, Ravindra, Babu, Raghavendra, Kumar, M.S[10] the females have a ridge density of 16/25 $mm^2$and males 15 /25 mm^2.

In the study conducted by Amit Patil, Amrit Malik, Trezashirole.[11] On 170 subjects from Dr. DY Patil Medical College Mumbai. The ridge density in males is between 8-12.90 / 25 mm ^{2}and 10.2 -15/ 25mm^2 in females.

Arun Kumar Agnihotri, Vandna Jowaheer, Anishta Allock[12] in their study involving 200 medical students, 100 men and 100 women, opined that women tend to have a higher ridge density in comparison with men.

Dhall L K and Kapoor B[13] conducted a study in 245 males and 246 females belonging to the Punjabis of Delhi region concluded that females have significantly higher ridge density than males in all five areas of finger upper radial, radial, ulnar, upper ulnar, and proximal.

Similar studies were conducted in other countries also. Wahdan, Amira & Khalifa, Heba[14] and summarized that the females showed significantly greater ridge density >1187/25mm^2 at a cut of value in their study involving 200 volunteers, 100 male, and 100 female Egyptian population.

In the study conducted on Northeastern Thai teenagers by Pattanawit Soanboon Somsong Nanakorn, Wibhu Kutanan[15] among 353 volunteers, 191 male and 162 females of age groups between 14 – 18 and 18 – 24 years, significant differences between genders and age groups were obtained. Females exhibited higher ridge density and narrow ridges than males, and a decrease in ridge density with age was

Table 1:

Variable	Gender=Male (n=60)			Gender=Female (n=60)					
		Mean	SD		Mean	SD	Mean Difference	t-value	P-Value
Age	60	19.5500	1.5118	60	19.1833	1.3960	-0.3667	-1.38	0.1701
Left hand	60	64.3833	1.5193	60	73.3833	1.2635	9.0000	33.37	<0.0001*
Right hand	60	64.1167	1.9230	60	75.2833	1.7378	11.1667	35.28	<0.0001*
Total	60	128.5000	2.8612	60	148.6667	2.3482	20.1667	45.20	<0.0001*

*- P<0.0001 (Very High Significant)

Table 2:

	Gender									
	Male					Female				
		Minimum	Maximum	Mean	Median	SD		Minimum	Maximum	Mean	Median
Age	60	18.00	22.00	19.55	19.500	1.5118	60	18.0	22.0	19.183	19.0
Left hand	60	62.00	67.00	64.383	64.000	1.5193	60	71.0	75.0	73.383	74.0
Right hand	60	62.00	67.00	64.117	64.000	1.9230	60	72.0	78.0	75.283	75.5
Total	60	124.0	134.0	128.500	128.000	2.8612	60	145.0	153.0	148.67	149.0

also noticed.

However, Maninder Kaur[16] found out that male prisoners showed more fingerprint ridge density than female prisoners in the study involving 125 Prisoners, 77 male and 48 Female prisoners of Haryana. This study is contrary to the present study and many similar other studies—the reasons for the same need to be evaluated.

5. Conclusion

The fingerprint ridge density among the females is higher than the males. The females showed a range of 145 to 153 ridges /0.25 sq. cms compared to males, the range being 124 to 134 ridges / 0.25 sq cms. The mean value of female to male is 14.8 with an SD of 234, and that of the male is 12.85 with an SD of 2.86.

There is no statistically significant fingerprint ridge density of left and right hands in males, but in females, the ridge density in the right hand is slightly higher, requiring further evaluation.

6. Limitations and Recommendations

The study was conducted involving Medical students of only one college of Andhra Pradesh, and the sample size is small (one hundred and twenty only). A large sample size involving more subjects across India will give more accurate results.

7. Source of Funding

Nil.

8. Conflicts of Interest

The authors declare no conflict of interest.

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